

REMARKS

Applicants request favorable consideration and allowance of the subject application in view of the preceding amendment and the following remarks.

Claims 1-3, 5, 7-13, and 37-59 are now presented for examination. Claims 47-53 and 55 have been cancelled without prejudice or disclaimer of subject matter.

Claims 1-3, 5, 7, 9, 10, 12, 13, 37-39, 42, 46 and 54 have been amended to define still more clearly what Applicants regard as their invention, in terms which distinguish over the art of record. Claims 56-59 have been added to assure Applicants of the full measure of protection to which they deem themselves entitled. Claims 1, 2, 10, 12 and 37 are the only independent claims.

Claims 1-3, 5, 7-13 and 37-54 have been rejected under 35 U.S.C. § 112, second paragraph, as being indefinite. The recitation of "at least one lens" in that the "at least one lens" is part of both the first and second imaging optical system. Claim 1 has been amended to recite "a first imaging optical system consisting of at least one first lens

In view of the foregoing, it is believed that Claims 1-3, 5, 7-13 and 37-54 as currently amended fully meet the requirements of 35 U.S.C. § 112, second paragraph.

Claim 2 has been objected to for repeating "a mirror having a negative refractive power". This repetition has been deleted.

Claims 37-46 have been indicated as allowable. As indicated, Claim 37 has been amended to recite "at least two lenses" rather than "at least one lens" and to change the phrase "is caused by said mirror to pass" to "passes". It is not believed that these changes affect the status of Claim 37 as allowable.

Claim 7-9 and 12 have been indicated as allowable if rewritten in independent form. Claim 12 originally depending from Claim 1 has been rewritten in independent form making the changes to "at least one lens" indicated for Claim 1 with respect to 35 U.S.C. § 112, second paragraph. Accordingly, it is believed that Claim 12 as currently amended is allowable.

Claims 1-3, 5, 13, 47-50 and 55 have been rejected under 35 U.S.C. § 102 as being anticipated by U.S. Patent No. 5,999,310 (Shafer et al.). Claim 11 has been rejected under 35 U.S.C. § 103 as being unpatentable over the Shafer et al. patent in view of U.S. Patent No. 5,623,365 (Kuba). Claim 54 has been rejected under 35 U.S.C. § 103 as being unpatentable over the Shafer et al. patent in view of U.S. Patent No. 5,631,721 (Stanton et al.).

Independent Claim 1 as currently amended is directed to a projection optical system in which a first imaging optical system consists of at least one first lens and at least one concave mirror to form an intermediate image of an object. A second imaging optical system consists of at least one second lens and at least one diffractive optical element to

project the intermediate image onto an image plane. A field optical system is disposed between the first and second imaging optical systems. The projection optical system is arranged to image on the image plane only abaxial light from the object.

In Applicants' view, Shafer et al. discloses an ultra-broadband ultraviolet (UV) catadioptric imaging microscope system with wide-range zoom which has a catadioptric lens group and a zooming tube lens group. The imaging microscope system has high optical resolution in the deep UV wavelengths, continuously adjustable magnification, and a high numerical aperture. The system integrates microscope modules such as objectives, tube lenses and zoom optics to reduce the number of components, and to simplify the system manufacturing process. A preferred arrangement offers excellent image quality across a very broad deep ultraviolet spectral range, combined with an all-refractive zooming tube lens. The zooming tube lens is modified to compensate for higher-

reflector (lines 51-54 of column 5) and Shafer et al.'s second image optical system (zoom lens group 139) has a refractive lens or a diffractive surface. In contrast to Shafer et al., it is a feature of Claim 1 that the first image optical system consists of a first lens and a concave mirror without a planar reflector and another feature that the second imaging optical system consists of a second lens and a diffractive element. It is a further feature of Claim 1 that the projection optical system is arranged to image, upon the image plane, only abaxial light from the object. In contrast, Shafer et al. shows in Fig. 4 and discloses the use of axial light to form an image which is directed away from and fails to suggest the use of only abaxial light from the object as in Claim 1. In at least the foregoing respects, it is believed that Claim 1 as currently amended is completely distinguished from Shafer et al. and is allowable thereover.

Independent Claim 2 as currently amended is directed to a projection optical system in which a first image optical system has at least one first lens and at least one concave mirror to form an intermediate image of an object. A second imaging optical system has at least one second lens and at least one diffractive optical element to project the intermediate image onto an image plane. A field optical system is disposed between the first and second imaging optical systems. Each lens, each mirror and each diffractive optical element of the projection optical system all have a positive power.

It is a feature of Claim 2 that each lens, each mirror and each diffractive optical element of the projection optical system has a positive power. Shafer et al. fails to teach or suggest the use of only positive power lens, mirrors and diffractive optical elements as in Claim 2. It is therefore believed that Claim 2 as currently amended is completely distinguished from Shafer et al. and is allowable thereover.

Independent Claim 10 as currently amended is directed to a projection optical system in which a first imaging optical system consists of at least one first lens and at least one concave mirror to form an intermediate image of an object. A second imaging optical system consists of at least one second lens and at least one diffractive optical element to project the intermediate image onto an image plane. A field optical system is disposed between the first and second imaging optical systems. A reflection surface is disposed adjacent to an intermediate image formed by the first imaging optical system. Abaxial light from the object as reflected and collected by the concave mirror is deflected by the reflection surface toward the second imaging optical system.

According to the invention of Claim 10 as currently amended, the first imaging optical system consists of a first lens and a concave mirror only, and the second imaging optical system consists of a second lens and a diffractive optical element only. A reflection surface adjacent the intermediate image directs the light from the concave surface to the second imaging optical system. As discussed with respect to Claim 1, Shafer et al.'s catadioptric lens group 122 includes a planar reflector 123 in addition to a meniscus lens 125 and a concave spherical reflector and Shafer et al.'s second image optical system (zoom lens group 139) only teaches a refractive lens or a diffractive surface. Further, Shafer et al. fails to teach or suggest the feature of a reflection surface adjacent the intermediate image by which the light from the concave surface is directed to the second imaging optical system as in Claim 10. It is therefore believed that Claim 10 as currently amended is completely distinguished from Shafer et al. and is allowable thereover.

Claims 1-3, 10, 13, 47-49 and 51 have been rejected under 35 U.S.C. § 102 as being anticipated by U.S. Patent No. 5,515,207 to Foo.

In Applicants' opinion, Foo discloses a reduction projection system with a large numerical aperture has an unobscured optical path without the need to resort to truncated lens elements. The system includes first and second reduction stages. The first reduction stage includes a first mirror group (20) and a first lens group (30). The second reduction stage includes a second mirror group (40) and a second lens group (50). Together, the first mirror group and the first lens group form an intermediate reduced image of the object at an intermediate image region (70). The second mirror group and the second lens group form a further reduced image at an image plane (15).

With respect to Claims 1 and 10, Foo shows (Fig. 1) a structure in which an intermediate image 70 of an object surface 12 is formed by a first imaging optical system having a refractive lens (30) and a reflection surface (20). The intermediate image is then re-imaged on an image plane 15 by a second imaging optical system having a reflection surface 40 and a lens 50. As a result, the second imaging optical system of Foo which reimages the intermediate image 70 consists of mirrors 40 and lens 50. Accordingly, it is not seen that Foo in any manner teaches or suggests the feature of Claims 1 and 10 of a second imaging optical system consisting of at least one second lens and at least one diffractive optical element for projecting the intermediate image onto an image plane. Further, Foo is devoid of any teaching or suggestion of the feature of Claim 1 that the projection optical system is arranged to image, upon the image plane, only abaxial light from the object. In view of the foregoing, It is believed that Claims 1 and 10 as currently amended are completely distinguished from Foo and are allowable.

In regard to Claim 2, Foo clearly discloses at least at lines 54-64 of column 3 that the first lens group 30 is characterized by low optical power that is negative.

Accordingly, it is not seen that Foo in any manner teaches or suggests the feature of Claim 2 of that each lens, each mirror and each diffractive optical element of the projection optical system all have a positive power. It is therefore believed that Claim 2 as currently amended is completely distinguished from Foo and is allowable.


A review of the other art of record has failed to reveal anything which, in Applicants' opinion, would remedy the deficiencies of the art discussed above, as references against the independent claims herein. Those claims are therefore believed patentable over the art of record.

The other claims in this application are each dependent from one or another of the independent claims discussed above and are therefore believed patentable for the same reasons. Since each dependent claim is also deemed to define an additional aspect of the invention, however, the individual consideration or reconsideration, as the case may be, of the patentability of each on its own merits is respectfully requested.

In view of the foregoing amendments and remarks, Applicants respectfully request favorable consideration and reconsideration and early passage to issue of the present application.

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Respectfully submitted,



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